Sustainable Chemistry and Pharmacy 9 (2018) 35–41

Contents lists available at ScienceDirect

Sustainable Chemistry and Pharmacy

journal homepage: www.elsevier.com/locate/scp

Chemical and biological evaluations of potent antiseptic cosmetic products obtained from *Momordica charantia* seed oil

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ARTICLE INFO

Keywords:
Natural antiseptic soap
Fatty acids
Saponification
Transesterification
Momordica charantia

ABSTRACT

The Principles of Green Chemistry was employed for the preparation of organic antiseptic soaps with improved skin sensitivity, reduced skin toxicity and improved biodegradability. Non-conventional and lesser known tropical seeds of *Momordica charantia* were used as the source of oil for the saponification processes. The fatty acid methyl esters of the oil were prepared via transesterification and subjected to GC–MS analysis to obtain the fatty acid composition of the oil and saponified products were subjected to various physicochemical and antimicrobial evaluations. The results indicated that stearic acid (18:0) and eleostearic acid (18:3) were the most abundant fatty acids making up 37.60% and 39.16%, respectively. Palmitic acid (16:0) 12.36%, oleic acid (18:1) 8.71%, linoleic acid (18:2) 0.67% and gamolenic acid (18:3) 1.50% were present in smaller amount in the oil. The oil is a viable source of polyunsaturated fatty acid which is required as essential fatty acids in the human body. The prepared soaps containing only natural additives (such as honey and shear butter) and components showed appreciable degree of hardness comparable to commercial Dudu Osun and the synthetic Lux soaps used as standards. This work demonstrates the probability of the preparation of green antiseptic soaps from the underutilized tropical seed of *M. charantia*. The seed oil and the allied products obviously have great potential for further advancement, development, research and applications in health and cosmetics sectors. The adopted approach could also assist maintaining a safe and healthy biotic and abiotic environment.

1. Introduction

Seeds are major source of oil with many applications such as dietary, paints, soap, oleochemicals in everywhere in the world. Apart from food and biochemical potentials, fats and oils are raw materials for coatings, paints, pharmaceuticals, soaps, detergent and the cosmetics industries (Ayoade and Amoo, 2015). The biological activity of several seeds has been reported (Muhammed et al., 2012; Aremu et al., 2015). Biological activity of a seed plant entails its ability to successfully slow or prevent the growth of disease pathogens (antimicrobial), ability to mop off free radicals in the body (antioxidant) and ability to keep cells from bursting (anti-inflammatory). Application of bioactive seeds in the making soap might confer on the soap several biological properties. The presence of natural antioxidants in oil could help in the management of diseases conditions such as skin cancers, rashes, skin dryness and other skin infections (Dillard and German, 2000).

The physicochemical characteristics of fatty acid compositions of fats and oils, besides their value for reference purposes, serve as useful guides to oil and fat analysts in determining the possible uses (Nagre et al., 2011).

Research has indicated that synthetic antioxidants induce allergic reactions in human, a disadvantage minimized in natural antioxidants found in seed oil (Joshi and Pawal, 2015; Suzuki, 2010). Similarly, development of microbial resistance had been credited to some modern commercial soaps that contain synthetic antimicrobial chemicals agents such as triclosan, trichlorocarbanilide and chloroxylenol, most of which are also reported to be carcinogenic and generate allergic reactions. Previous research efforts had indicated the viability of obtaining NaOH and KOH (lye) from wood ash for the production of natural soaps (Atolani et al., 2016; Zauro et al., 2016; Atiku et al., 2014).

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https://doi.org/10.1016/j.scp.2018.05.005
Received 28 January 2018; Received in revised form 11 May 2018; Accepted 21 May 2018

Soaps produced from the natural lye and underutilized bioactive oil using green chemistry principle offers products that are easily adaptable to human skin, biodegradable, environmental friendly, inhibit the growth of disease pathogens, scavenge of free radicals in the body, mild on cells, economically valuable, sustainable and environmentally friendly.

The production of soaps from completely natural means will significantly address one of United Nations goals of environmental sustainability pertaining to persistent environmental pollution caused by huge non-biodegradable soaps in the market. This will also enable less developed nations to reduce or eliminate the use and generation of hazardous substances (Lancaster, 2002; Anastas and Eghbali, 2010). Soap is a mixture of sodium or potassium salts of naturally occurring fatty acids (Gunstone, 2012). The physicochemical characteristic of soap depends on strength and purity of alkali, the composition of the oil used and degree of saponification. Physicochemical characteristics which include pH, solubility, hardness, washing efficiency and free alkalinity are used in determining the overall quality of the soap (Roila et al., 2001).

M. charantia (Karela) commonly known as Bitter melon or Bitter gourd is tropical and subtropical climber of the family Cucurbitaceae. It is commonly found in China, Malaysia, India and tropical Africa. The fruits extract is used in tradition medicines as medication to cure various diseases like: rheumatism, gout, worms, colic, liver disease (Agrawal and Kamal, 2004).

M. charantia contains an array of biologically active phytocompounds such as triterpenes, proteins, steroids, alkaloids, saponins, flavonoids and fatty acids responsible for the antifungal, antibacterial, antiparasitic, antiviral, antifertility, antitumor, hypoglycemic and anticarcinogenic properties (Beloin et al., 2005; Grover and Yadav, 2004).

M. charantia leaves, stem and bark are known to contain compounds which includes momordicin, charantin, charine, cryptoxanthin, cucurbitins, cucurbitacins, cucurbitanes, cycloartenols, diosgenin, α-stearic acids, erythrodiol, galacturonic acids and gentisic acid (Braca et al., 2008).

This present study aimed at adopting the principles of green Chemistry for the sustainable production of natural cosmetic soaps from the underutilized tropical seed of *M. charantia* with improved antiseptic properties ability to ameliorate natural beauty, attractiveness and appearance of skin and hair.

2. Materials and methods

2.1. Collection of plant material

The seed of *M. charantia* were collected within Ilorin metropolis, Kwara State, Nigeria. The plant material was identified at the Herbarium of the Department of Plant Biology, University of Ilorin, Ilorin, Nigeria where voucher specimen numbers UILH/003/916 was obtained.

The seeds were dried at ambient temperature, de-shelled, pulverized and kept in a cool dry place for further work.

2.2. Extraction of Oil from M. charantia Seed

The pulverized *M. charantia* seed (300 g) was subjected to Soxhlet extraction using n-hexane as the extracting solvent at 60 °C for approximately 3 h. The crude extract was concentrated via distillation using rotatory evaporator to obtain the oil (Islam et al., 2015).

2.3. Determination of the physicochemical parameter of the oil

The physicochemical parameters of the oil were determined using standard procedures with slight modification where applicable (AOCS, 2007; Gerpen, 2005; Ibeto et al., 2012). Odor, color and physical state were determined by sensory evaluation.

2.4. Preparation of fatty acids methyl ester (FAMEs)

One g of the seed oils was weigh into a round bottom flask. 20 mL of 0.1 M methanolic KOH was added. The mixtures were refluxed for 1 h. After refluxing, supernatant obtained was cooled, transferred to a separating funnel and extracted with n-Hexane twice. The oil layer was concentrated in warm water bath and the oils derived kept in a vial and refrigerated until analysed using GC-MS (Atolani et al., 2016).

2.5. GC-MS analysis of the oils

The fatty acid composition of the transesterified oil was analysed using an Agilent Technology 7890A gas chromatograph GC-FID, equipped with a fused silica capillary column HP-5MS (30 m by 0.32, 0.5 μm film thickness) on ultra-pure helium gas and coupled to a mass selective detector (mass spectrometer). The chemical compositions of the product obtained was identified by comparison of their MS spectral with data obtained from National Institute Standard and Technology (NIST, 2008) database. The relative percentages of the constituent compounds were percentages from the GC peak areas based on the total ion chromatogram.

2.6. Lye preparation

The wood ash was collected from a local bakery in Ilorin, Kwara State metropolis, sieved and weighed. 30 kg of the wood ash was soaked in 75 L of warm water for 24 h and then filtered using clean white layered clothe to obtain the lye, a brown colored solution. The solution was later concentrated to 4 l prior to use in soap making (Atolani et al., 2016).

2.7. pH, Conductivity and turbidity tests

The pH was determined using pH meter (827 pH lab model), conductivity of the lye solutions was determined using an EC 214 Conductivity Meter while the turbidity was determined using 2100N Turbidity Meter (Atolani et al., 2016).

2.8. Standardization of the lye using flame atomic absorption spectrometric

The extracted lye (100 mL) solution was filtered using a Whatman No. 1 filter paper into a 250 mL beaker, 2 mL concentrated HCl and 5 mL concentrated nitric acid were added and digested on a hot plate to 20 mL. The digested solution was filtered using a Whatman No. 1 filter paper into a 100 mL volumetric flask and adjusted to the mark with deionized water. The amount of Na^+ and K^+ ion in the weighted ash was determined by Flame Atomic Absorption Spectrometric method using the Agilent 240 FS double-beam AA spectrometer.

2.9. Saponification reaction

The extracted oil was saponified using hot process since the cold process produced no instant saponification. 5 mL of the oils were heated to boiling in a beaker and 50 mL of lye solution was added to the boiling oil with constant stirring. A thick semi-solid mass of soap was obtained, allowed to cool and set for some weeks following standard procedure (Warra et al., 2009; Ogunsuyi and Akinnawo, 2012). Additives which include 0.3 mg of Shear butter fat (for skin nourishment) and 0.4 mg of honey (for skin rejuvenation) were added after completing the saponification process but before the hardening of the semi-solid matter.

2.10. Soap characterizations

The saponified product was characterized for its pH, foaming ability, hardness, cleaning effectiveness, solubility and total alkalinity whilst comparing their values with commercial soap samples using